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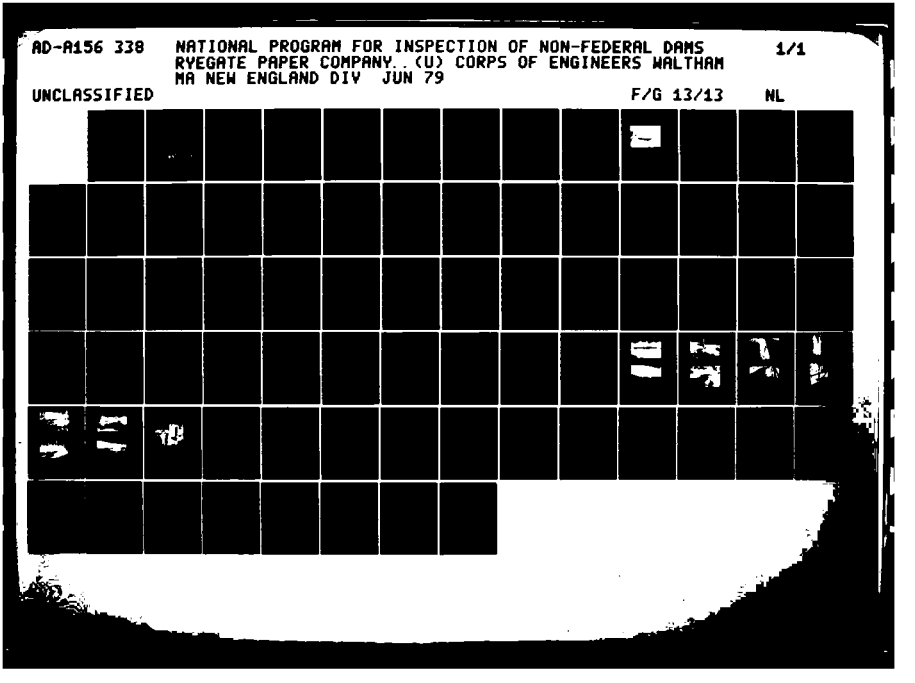

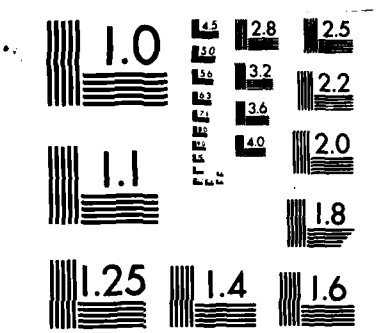

CONNECTICUT RIVER BASIN
BATH, NEW HAMPSHIRE

RYEGATE PAPER COMPANY DAM
NH 00014

STATE NO 17.01

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JUNE 1979

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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Bath, New Hampshire
Connecticut River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam has a hydraulic height of 28 ft., has a spillway topwidth of 5 ft., and 485 ft. long. The dam is in fair condition. The major concern is the state of repair of the spillway and the effect that overtopping of the dam and spillway under flood conditions would have on the stability of the dam, especially the spillway itself. It is intermediate in size with a hazard potential of low.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

ATTENTION

NEDED

NOV 15 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Ryegate Paper Company Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Claremont Paper Mill, Claremont, New Hampshire.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00014
Name of Dam:	Ryegate Paper Company Dam
Town:	Bath, New Hampshire; Ryegate, Vermont
County & State:	Grafton County, New Hampshire Caledonia County, Vermont
River:	Connecticut River
Date of Inspection:	May 7, 1979

BRIEF ASSESSMENT

Ryegate Paper Company has a hydraulic height of 28 feet, has a spillway topwidth of 5 feet, and is 485 feet long. It is a run-of-the-river gravity dam consisting of a concrete powerhouse and training wall and a rock-filled, timber crib spillway 375 feet long. The spillway crest is 15.5 feet above the streambed at the downstream toe. The dam spans a reach of the Connecticut River and is located in both New Hampshire and Vermont. Maximum storage capacity is about 7,985 acre-feet. The dam is presently being used to supply process water for the owner, Claremont Paper Mill (CPM). The storage area is approximately 4 miles in length with a surface area of about 290 acres.

The dam is in fair condition. The major concern is the state of repair of the spillway and the effect that overtopping of the dam and spillway under flood conditions would have on the stability of the dam, especially the spillway itself. Lesser concerns are: broken and missing planking near the west end of the dam; an apparent sag of about one foot in the crest of the spillway near the east end; and lack of written operational and maintenance procedures including a downstream warning system in event of emergency conditions.

Based on intermediate size and low hazard classification in accordance with Corps guidelines, the test flood that would be normally used to determine the overtopping elevation is one-half the Probable Maximum Flood (PMF). For this dam it was impractical to determine the overtopping elevation for the test flood because the dam is completely inundated at a flood much smaller in magnitude. At the top of dam, the spillway will pass 47,000 cfs or about 39% of the test flood before overtopping the west abutment. Though the dam is founded on bedrock, the spillway section has deteriorated to a point where it could not withstand any severe degree of overtopping before damage were to occur to the dam. In 1936 the west abutment was overtopped by 4 feet (17 feet above the spillway). A major breach at top of dam would probably result in no loss of life and minimal property damage. (See Section 5.)

The owner, Claremont Paper Mill, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I Inspection Report.

Warren A. Guinan

Warren A. Guinan
Project Manager
N.H. P.E. No. 2339

This Phase I Inspection Report on Ryegate Paper Company Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

JOSEPH W. HINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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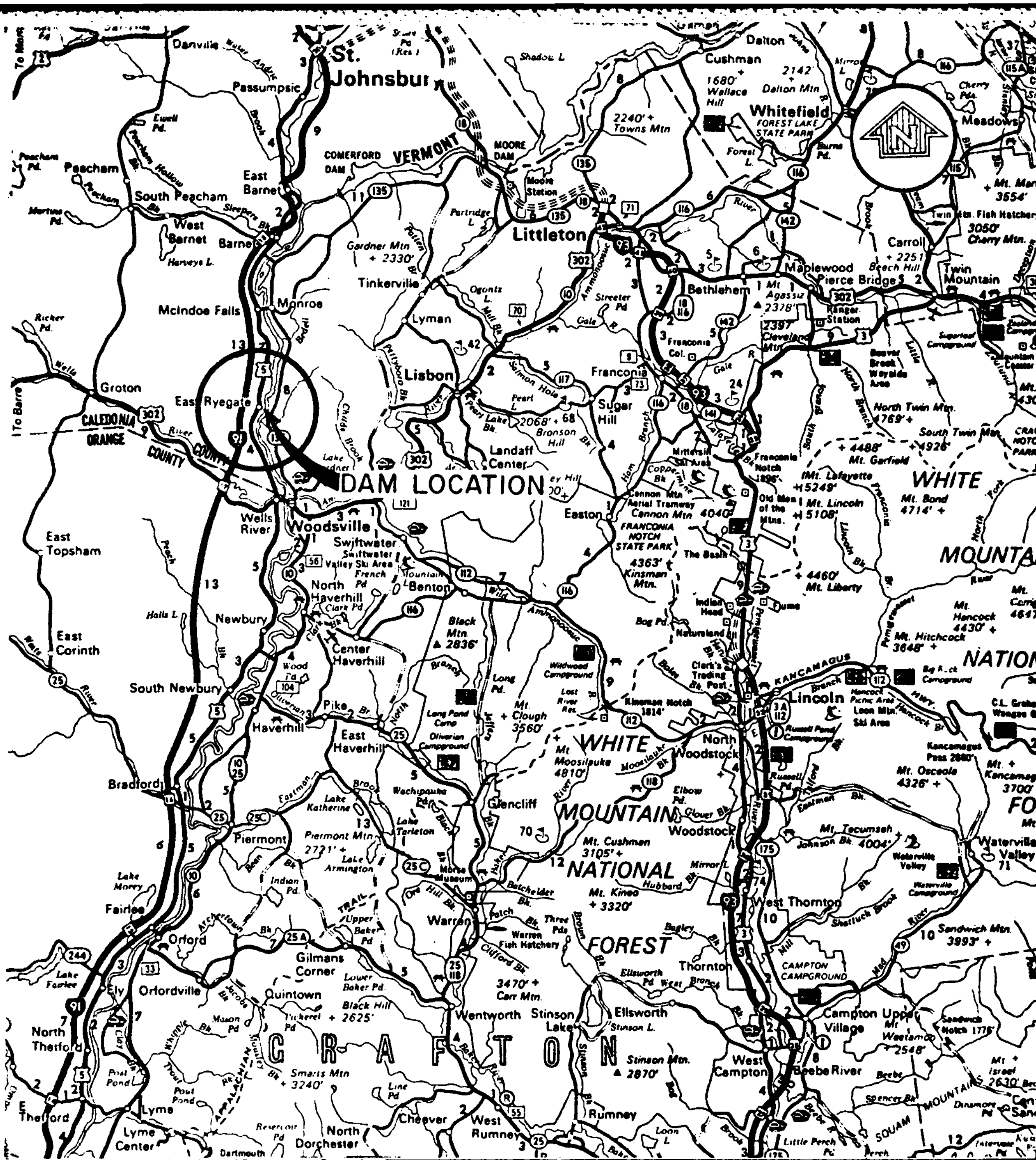
Figure 1 - Overview of the Ryegate Paper Company Dam.



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

RYEGATE PAPER COMPANY DAM LOCATION MAP

CONNECTICUT RIVER NEW HAMPSHIRE

SCALE: SEE BAR SCALE

DATE: JUNE, 1979

SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
RYEGATE PAPER COMPANY DAM

SECTION I
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of March 22, 1979 from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0050 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Ryegate Paper Company Dam is located in the Towns of Bath, New Hampshire and Ryegate, Vermont and is a run-of-the-river dam spanning the Connecticut River. After discharging over the dam, the Connecticut River flows southerly for a distance of approximately 270 miles before emptying into Long Island Sound at Lynde Point, Old Saybrook, Connecticut. Ryegate Paper Company Dam is shown on the U.S.G.S. 7.5 Minute Quadrangle, Woodsville, Vt. - N.H. and 15 Minute Quadrangle, Woodsville, Vt. - N.H., with coordinates approximately at N 44° 12' 30", W 72° 03' 30", Grafton County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Ryegate Paper Company Dam is a gravity dam consisting of a concrete powerhouse and training wall section at the west end and a rock-filled timber crib spillway section east of the training wall. The east abutment of the dam is in bedrock. The dam totals 485 feet in length and has a hydraulic height of 28 feet. The spillway

section is about 375 feet in length, the crest is 15.5 feet above the streambed at the downstream toe.

c. Size Classification. Intermediate (hydraulic height - 28 feet; storage - 7,985 acre-feet) based on storage ($\geq$ 1,000 to $<$ 50,000 acre-feet) as given in Recommended Guidelines for Safety Inspections of Dams.

d. Hazard Classification. Low hazard. A major breach would probably result in no loss of life and minimal property damage. (See 5.1 f.)

e. Ownership. The dam was reported to have been constructed prior to 1909. The earliest record of ownership is the Ryegate Paper Company. Ownership was acquired by the Claremont Paper Mill (CPM) of Claremont, New Hampshire from the Ryegate Paper Company at some unknown date. CPM presently owns, maintains, and controls the dam.

f. Operator. The current owner and operator of the Ryegate Paper Company Dam is the Claremont Paper Mill, 131 Sullivan Street, Claremont, New Hampshire 03743 (phone: 603/542-2592) and East Ryegate, Vermont 05042 (phone: 802/757-3353).

g. Purpose of Dam. The original purpose for construction of the dam was not disclosed; however, in 1909 three 68-inch Sampson Vertical Turbines were installed to replace the original water wheels. The purpose of these wheels was to drive the pulp grinders in the paper mill at the damsite. In 1916 one and in 1917 two more 68-inch Sampson Vertical Turbines were installed to replace the remaining three original water wheels. In 1929 one of the Vertical Turbines which had been damaged by ice conditions was replaced. In 1967 all six turbines were removed. Five of the six head gates have been permanently closed and blocked off. The current purpose of the dam is to provide process water for the paper mill through the single usable head gate.

h. Design and Construction History. No information was disclosed regarding the design and construction of the original dam other than it was constructed prior to 1909. One plan was disclosed entitled "Profile and Sections of Dam and Log Sluice-Ryegate Paper Company". This plan was drawn by George F. Hardy, Architect and Engineer, 308 Broadway Street, New York, New York. The date on this plan was November 20, 1906. This plan reflected a profile and sections through the rock-filled timber crib spillway and the log sluice. This sluice has been removed at some undisclosed date. Repairs were made in 1960 consisting of intrusion grout into the old rock-fill crib. For details concerning the mill building and head gates, see Section 3.1 c. 2.

i. Normal Operating Procedures. No written operating procedures were disclosed. Flashboards were utilized at one time on the spillway; however, they have not been used since the turbines were removed in 1967. Current operating procedures with regards to the former head gates in the mill building is discussed in Section 3.1 c. 2.

1.3 Pertinent Data.

a. Drainage Area. The drainage area consists of 2,215 square miles (1,417,600 acres) of hilly upland. About 75% of the land is forested with a number of natural and man-made storage areas present in the upstream watershed.

b. Discharge at Damsite

(1) Outlet works (conduits) - High level gate 4'W x 5'H at invert elevation 418.3' MSL. Gate capacity at top of dam - 151 cfs @ 433.8' MSL.

(2) The maximum known discharge at damsite is approximately 58,000 cfs, occurring in 1936. There is a U.S.G.S. gaging station on the Connecticut River approximately 4.5 miles downstream at Wells River, Vermont. Maximum known discharge at this gage with 27 years of record and a drainage area of 2,644 square miles is 57,100 cfs during July 1973.

(3) Spillway capacity @ top of dam - 47,000 cfs @ 433.8' MSL

(4) Spillway capacity @ test flood elevation-(See Section 5.1 e.)

(5) Gated spillway capacity @ top of dam elevation - not applicable

(6) Gated spillway capacity @ test flood elevation - not applicable

(7) Total spillway capacity @ test flood elevation - (See Section 5.1 e.)

(8) Total project discharge @ test flood elevation - 121,800 cfs @ 470' MSL (See Section 5.1 e.)

c. Elevation (feet above MSL)

(1) Streambed at centerline of dam - 406.1 (at downstream toe)

(2) Maximum tailwater - The maximum tailwater occurred during the 1936 flood and was reported to be 437.7' MSL.

(3) Upstream portal invert high-level gate 418.3' MSL. Upstream portal invert low-level gate - could not be obtained at time of inspection.

(4) Recreation pool - not applicable

(5) Full flood control pool - not applicable

(6) Spillway crest - 421.6

(7) Design surcharge (original design) - unknown

(8) Top of dam - 433.8

(9) Test flood pool - 470

d. Reservoir (miles)

(1) Length of maximum pool - 4

(2) Length of pool at spillway crest - 4

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 4,360 (approximate)

(4) Top of dam - 7,985 (approximate)

(5) Test flood pool - (See Section 5.1 e.)

f. Reservoir Surface (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway Crest - 290 acres (approximate)

(4) Test flood pool - (See Section 5.1 e.)

(5) Top of dam - 296 (approximate)

g. Dam

(1) Type - Gravity dam on ledge consisting of a concrete powerhouse and training wall and a rock-filled, timber crib spillway.

(2) Length - 485'

(3) Height - 28' (structural height)

(4) Top width - 5' (spillway)

(5) Side slopes - 30° slope on upstream face (flattening at crest). Batter 4" per foot on downstream face of spillway; vertical west abutment; natural rock and earth on east abutment.

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable (See j. below.)

i. Spillway

(1) Type - rock-filled timber crib.

(2) Length of wier - 375'

(3) Crest elevation - 421.6'MSL

(4) Gates - none

(5) U/S channel - The approach channel to the dam consists of the Connecticut River about 600 feet in width. The banks are rolling and wooded. The McIndoes Hydropower Dam is located four miles upstream.

(6) D/S channel - The channel appears to be bedrock with some large loose boulders and some island sand bars. The banks of the channel of the Connecticut River downstream of the dam are also rolling and wooded. Parts of the Ryegate Paper Mill are located at tailwater level on the west side immediately below the dam. About 4.5 miles downstream of the dam, in Woodsville, N.H., is an area consisting of 14 inhabited structures in the Connecticut floodplain; a group of 7 houses located in the floodplain in Wells River, Vermont.

j. Regulating Outlets. A 4'W x 5'H high level outlet is located in the training wall adjacent to the spillway with invert elevation at 418.3'MSL. The low-level outlet was submerged on the day of inspection, therefore, no dimensions or elevations could be determined.

SECTION 2
ENGINEERING DATA

2.1 Design

The only design data disclosed was a copy of an original drawing entitled, "Profile and Sections of Dam and Log Sluice - Ryegate Paper Company" by George F. Hardy, Architect and Engineer, 308 Broadway Street, New York, New York, dated November 20, 1906. Three years of data showing the effects of water released at Lake Francis were kept and charted from 1940 through 1942. The plant design and capacity of 1600 cfs was marked and tested during this period. The Ryegate Paper Company Dam was repaired in 1960 consisting of an intrusion grout to seal leaks in the rock-filled timber crib dam.

2.2 Construction

In 1909, the Paper Mill constructed a grinder plant utilizing six Leffel wheels powered by flow from the Connecticut River. The wheels were of the vertical turbine type and were directly connected to pulp grinders at the operating floor of the plant. From 1909 until 1966 numerous modifications and repairs were made to the wheels and grinder equipment. In 1966 the Leffel & Company prepared a preliminary feasibility report regarding the hydroelectric development of the grinder plant. The Plant Manager stated that in 1967 all six water wheels were removed from the plant and the grinder building was left unused for some period of time.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. Limited engineering data was found regarding the Ryegate Paper Company Dam.

b. Adequacy. The final assessment and recommendations of this investigation are based on the plans of the dam obtained, the visual inspection, and the hydrologic and hydraulic calculations.

c. Validity. Because of the flow of water over the dam at the time of inspection, field measurements could not be taken to validate the reported dimensions and elevations; however, the general appearance of the structure that was visible confirmed that no major changes have been effected.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Ryegate Paper Company Dam is a low run-of-the-river dam which impounds a reservoir of intermediate size. The watershed above the dam is rolling and partially wooded. The downstream area is also rolling and partially wooded.

b. Dam. Ryegate Paper Company Dam is a rock-filled, timber crib dam. It has a hydraulic height of 28 feet and totals 485 feet in length. (See Appendix C-Figure 2.) Approximately 1.5 feet of water was flowing over the dam at the time of the inspection. The timber structure itself was barely visible beneath the overflowing water. Near the east end of the dam there appears to be a sag in the crest of the order of one foot, but with the water flowing over the structure, it is not possible to determine whether this is the result of a failure of the timber frame, decking, rock-fill or something else. (See Appendix C-Figure 3.) Near the west end of the dam some planking appears to be missing or broken. The west abutment of the dam consists of a mill building. (See Appendix C-Figure 4.) Bedrock is exposed on the west bank next to the forebay channel upstream of the mill. The east abutment of the dam is bedrock. (See Appendix C-Figure 5.)

c. Appurtenant Structures.

(1) Training Wall. A 12' wide X 54' long concrete training wall located at the west end of the dam, connected to the end of the mill building, acts to divert flow from the Ryegate Paper Company Dam impoundment to the 6 inlet bays of the mill.

The training wall was observed to be in fair condition. All sides of the wall revealed some surface deterioration to a maximum depth of six inches. (See Appendix C-Figure 6.) A hairline crack was noticed at the center of the wall and having an east-west orientation approximately opposite the crest of the dam. (See Appendix C-Figure 7.) Considerable efflorescence was observed on the sides of the wall at cracks. (See Appendix C-Figure 6.) Also rust staining was observed at embedded steel items.

High and low-level outlets exist through the training wall which have a capability to discharge flow from the grinder building inlet channel to the tailwater pool. The low-level outlet and slide gate was submerged on the day of the inspection and therefore could not be inspected. (See Appendix C-Figure 8.) The single shaft, completely enclosed, crank operated mechanism were observed to be in good condition. (See Appendix C-Figure 9.) The dimensions of the high-level outlet could not be accurately determined due to the flow through the structure. A 4' wide by 5' high steel gate and operating mechanism were observed to be in good operating condition. (See Appendix C-Figure 9.)

The third ungated opening approximately 4' wide by 6' high through the training wall, located approximately 5' upstream of the grinder mill building is above the trash rack access bridge. The opening may have been used to discharge debris collected from the trash racks into the downstream channel. (See Appendix C-Figure 10.)

(2) Mill Building. The grinder mill building which is approximately 110 feet long forms the portion of the dam between the training wall and the west abutment. (See Appendix C-Figure 11.) The visible portion of the grinder mill building bay inlet gates, trash rack, gear and wheel operating mechanism are in poor and rusted condition and appear not to have been in service for quite some time. (See Appendix C-Figure 11.) The wooden framework and platform supporting these mechanisms is also in poor, rotten condition and its structural adequacy is questionable. Originally the 6 bays housed vertical turbine water wheels which were directly connected to pulp grinders within the mill. Presently four of the 6 bays are permanently blocked-off, 3 are currently being utilized as wastewater storage, and one as plant effluent pumping and mixing equipment chamber. Of the two remaining bays the one adjacent to the papermill is utilized as a plant process water intake and the bay at the east end of the grinder mill is currently unused and left idle. The main floor of the grinder building is currently being used for wastewater treatment equipment. The visible portion of the building indicated the superstructure is in good condition and the concrete foundation did not reveal any evidence of movement or distress. The visible portions of the concrete indicate only surface spalling and deterioration. The interior of the pumping and mixing equipment bay was observed to have surface spalling and erosion to a depth of 3 to 4 inches. Although the bay floor was wet it could not be determined if the upstream headwall was leaking.

d. Reservoir Area. The watershed above the reservoir is rolling and partially wooded. It was not possible to see deep enough below the water surface to determine whether significant sedimentation has occured in the river bottom behind the dam. Trees are growing on the banks of the river upstream of the dam, but the river itself is wide and unobstructed. (See Appendix C-Figure 12.) Some siltation was observed in the inlet channel to the mill building; however, because it was submerged the extent of silt could not be determined.

e. Downstream Channel. The valley downstream of the dam as far as Woodsville, N.H. has generally steep high sides. Trees are growing on the banks of the river, but the river itself is wide and unobstructed immediately downstream of the dam. (See Appendix C-Figure 7.) Woodsville, New Hampshire and Wells River, Vermont are located about 4½ miles downstream of the dam. A group of 14 houses and the National Guard Armory are located in the floodplain of the Connecticut River in Woodsville; a group of 7 houses is located in the floodplain in Wells River. A U.S.G.S. gaging station is located near these houses on the Vermont side of the Connecticut River.

3.2 Evaluation

Because water was flowing over the dam it is not possible to evaluate adequately the condition of the rock-filled timber crib structure itself. However, based on the limited visual examination that could be made, it appears that the dam may be in fair condition. The one foot sag near the east abutment is the most significant concern.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

Presently, the former grinder building is being utilized as part of the mill's pollution control project. All of the existing turbines and grinders have been removed. Four of the six gates have been permanently closed or blocked off. Three of the bays are currently being used as wastewater storage for plant effluent, one bay is utilized for plant process water intake, one bay is used for plant effluent pumping and mixing equipment and also contains a diesel powered fire pump. The bay nearest the dam is not currently being used for any purpose.

4.2 Maintenance of the Dam

The Claremont Paper Mill (CPM) is responsible for the maintenance of the Ryegate Paper Company Dam.

4.3 Maintenance of Operating Facilities

No formal maintenance program was disclosed.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Ryegate Paper Company Dam.

4.5 Evaluation

The present operational and maintenance procedures are not adequate to ensure that all problems encountered be remedied within a reasonable amount of time.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Ryegate Paper Company Dam is a low, run-of-the river dam which impounds a reservoir of intermediate size. The total length of the dam is 485 feet of which 375 feet consists of a rock-filled timber crib spillway. The top of the dam is 12 feet above the spillway crest. Though the dam is located on bedrock, the spillway section has deteriorated to a point where it could not withstand any severe degree of overtopping before damage were to occur to the dam.

b. Design Data. No hydrologic or hydraulic data were disclosed.

c. Experience Data. From observation of the high water marks on the mill building, during the 1936 flood approximately 4 feet of water was flowing over the abutments (to elevation 437.7' MSL). (See Appendix C - Figure 14.) The high water mark from 1968 was 426' MSL, and in 1972 was 429' MSL.

d. Visual Observations. Because of a considerable amount of water flowing over the spillway at the time of the inspection, no visual observation of the spillway structure was possible. It was noted, however, that a one foot sag in the crest of the spillway near the east end of the dam has developed.

e. Test Flood Analysis. Ryegate Paper Company Dam is classified as being intermediate in size having a hydraulic height of 28 feet and a maximum storage capacity of 7,985 acre-feet; the dam was determined to have a Low Hazard Classification. Because of the rolling characteristics of the watershed a CSM rate of 2,215, taken from the Recommended Guidelines for Safety Inspection of Dams, was used in calculating the ½ PMF test flood of 121,800 cfs.

From an analysis of historic data and spillway hydraulics, it was determined that the discharge capacity of the dam is significantly affected by tailwater conditions of the Connecticut River during flood conditions. At a discharge of 30,000 cfs the tailwater elevation begins to have an effect on the discharge capacity of the spillway. At about 70,000 cfs the tailwater and spillway discharge elevation are equal (the spillway is submerged) and the dam ceases to cause any change in the flood profile. Therefore, an overtopping analysis using the ½ PMF flow of 121,800 cfs is not relevant.

Maximum discharge capacity at top of dam was computed to be 47,000 cfs which is only 39% of the test flood.

f. Dam Failure Analysis. The impact of failure of the dam at top of dam and normal flow conditions (spillway) were assessed using the Guidance for Estimating Downstream Dam Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to two developed areas consisting of about 14 inhabited structures (elevation 415' MSL) and the National Guard Armory located on the east bank of the Connecticut River

about 4.5 miles downstream of the dam in Woodsville, N.H. and 7 inhabited structures (elevation 420' MSL) on the west bank in Wells River, Vermont.

The antecedent flow over the spillway just before a breach at top of dam would already create a flooding and damage situation before the dam would fail. The small increase in stage (1.8') due to failure would not significantly increase damages. The next major damage area occurs at elevation 420' MSL.

A breach at normal flow conditions (spillway) would not be attributable to enough water (27,000 cfs) to the damage area such that the water surface of the Connecticut River would reach the first damage elevation of 415' MSL.

Based on the conclusions of this analysis, Ryegate Dam was given a Low Hazard Classification.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Because water was flowing over the dam to a depth of about 1.5 feet at the time of the inspection, only very limited visual observations could be made as to the condition of the dam. Two observations indicate that the structural condition of the spillway section of the dam is poor:

(1) An apparent sag of about one foot in the crest of the dam near the east end.

(2) Broken and missing planking near the west end of the dam.

b. Design and Construction Data. The only design data disclosed was the drawing mentioned in Section 1.h. No construction information was disclosed. Other inspection reports and documents indicate that the dam is a rock-filled timber crib.

c. Operating Records. Information from personnel at the Claremont Paper Mill (CPM) indicates that the west abutment of the dam was overtopped by 4 feet during the flood of 1936. (This was 17 feet above the spillway crest.)

d. Post-Construction Changes. Available documents indicate that plans were made in 1960 to use intrusion grout to seal leaks and fill voids in the rockfill. It is believed that the grouting was carried out.

e. Seismic Stability. Ryegate Paper Company Dam is in Seismic Zone 2 and in accordance with the recommended guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that the dam is probably in fair condition. The principal visual evidence on which this tentative conclusion is based is as follows:

(1) An apparent sag of about one foot in the crest of the spillway near the east end.

(2) Broken and missing planking near the west end of the spillway.

(3) The deteriorated condition of the training wall.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection. Because of the flow of water, it was not possible to adequately evaluate the structural condition of the spillway portion of the dam. The concrete abutment on the west side and the appurtenant features are in fair to good condition.

c. Urgency. The recommendations made in 7.2 and 7.3 below should be implemented by the owner within one year after receipt of this Phase I report.

d. Need for Additional Information. For the purpose of evaluating the structural condition of the dam, it should be inspected when no water is flowing over the crest. Such an inspection may require cofferdamming to effect dewatering.

7.2 Recommendation

The owner should engage a Registered Professional Engineer to:

(1) Evaluate the structural condition of the dam, especially the rock-filled timber crip portion.

(2) Investigate, design, and construct repairs to correct the deteriorated protions of the training wall.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Check the dam and appurtenant structures once each month.

(2) Patch cracks and spalled concrete in the west abutment.

(3) Inspect and insure operation of the low-level gates.

(4) Engage a Registered Professional Engineer to make a comprehensive technical inspection of the dam once every year.

(5) Establish a surveillance program for use during and immediately following periods of heavy rainfall or snowmelt, and also a warning program to follow in case of emergency conditions.

7.4 Alternatives

No practical alternatives to the recommendations and remedial measures at this time.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Ryegate Dam, N.H. DATE May 7, 1979

TIME 11:11 AM

WEATHER Sunny, cool

W.S. ELEV. U.S. 423.1 DN.S. 412.4

PARTY:

1. Warren Guinan
2. Stephen Gilman
3. Robert Ojendyk
4. Gary Blanchette
5. John Regan
6. Pattu Kesavan
7. Ronald Hirschfeld
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	W. Guinan/J. Regan	
2.	Structural Stability	S. Gilman/G. Blanchette	
3.	Soils & Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Ryegate Dam, N.H. DATE May 7, 1979

PROJECT FEATURE Intake Structure NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Outlet works refers to inlet to power tunnels under mill building
a. Approach Channel	
Slope Conditions	Good
Bottom Conditions	Not visible beneath water surfaces.
Rock Slides or Falls	None
Log Boom	None
Debris	None visible
Condition of Concrete Lining	Drains (or weepholes?)
Drains or Weep Holes	In low concrete retaining wall at west bank (abutment) of intake channel
b. Intake Structure	
Condition of Concrete	Fair - Some evidence of surface spalling
Stop Logs and Slots	Not visible

PERIODIC INSPECTION CHECKLIST

PROJECT Ryegate Dam, N.H. DATE May 7, 1979

PROJECT FEATURE Control Tower NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Fair - Some evidence of surface spalling
Condition of Joints	Little indication of movement
Spalling	Surface spalling of walls 3" depth max
Visible Reinforcing	None
Rusting or Staining of Concrete	Some at imbedded steel items
Any Seepage or Efflorescence	None visible
Joint Alignment	Not applicable
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	Yes - Steel Gate Operators and Supports rusted
b. Mechanical and Electrical	
Air Vents	None apparent
Float Wells	None Apparent
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	Closed - Not visible
Emergency Gates	Upper gate Steel - Rusted
Lightning Protection System	None
Emergency Power System	None
Wiring and Lighting System	None
Plant Personnel say gates have not	been used in many years.

PERIODIC INSPECTION CHECKLIST

PROJECT Ryegate Dam, N.H. DATE May 7, 1979

PROJECT FEATURE Spillway NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees, but channel is wide
Floor of Approach Channel	Not visible beneath water surface
b. Weir and Training Walls	Weir not visible
General Condition of Concrete Training Wall - Fair	Considerable surface spalling, top deck cracked - transverse.
Rust or Staining	
Spalling	Surface spalling - 6" max. depth
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None apparent
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees, but channel is wide
Floor of Channel	Bedrock
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT Ryegate Dam, N.H. DATE May 7, 1979

PROJECT FEATURE Service Bridge NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	None
Anchor Bolts	None
Bridge Seat	Not applicable
Longitudinal Members	Steel - surface rusted
Underside of Deck	
Secondary Bracing	
Deck	Wood - 2½ plank - deteriorated
Drainage System	
Railings	Fair - surface rusted
Expansion Joints	None
Paint	Poor
b. Abutment & Piers	
General Condition of Concrete	Fair
Alignment of Abutment	Good
Approach to Bridge	Fair
Condition of Seat & Backwall	Not visible

PROJECT Ryegate Dam, N.H. DATE May 7, 1979

PROJECT FEATURE Reservoir NAME R. Ojendyk

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Some observed in forebays
Changes in Watershed Runoff Potential	None
Upstream Hazards	None
Downstream Hazards	4.5 miles downstream, 14 houses on east bank and 7 houses on west bank.
Alert Facilities	None posted
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None posted

APPENDIX B

ENGINEERING DATA

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: Bath Dam Number: 17.01

Inspected by: SCB Date: 15 Aug 1974

Local name of dam or water body: _____

Owner: Ryegate Paper Address: _____

Owner (was)/was not interviewed during inspection.

Drainage Area: _____ sq. mi. Stream: Conn River

Pond Area: _____ Acre, Storage _____ Ac-Ft. Max. Head 12 Ft.

Foundation: Type _____, Seepage present at toe - Yes (No), _____

Spillway: Type Log Crib, Conc. Filled Freeboard over perm. crest: _____,

Width 375, Flashboard height None,

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type _____, Condition: Good, Fair, Poor

Gates or Pond Drain: Size _____ Capacity _____ Type None

Lifting apparatus _____ Operational condition _____

Changes since construction or last inspection: _____

Downstream development: _____

This dam (would)/would not be a menace if it failed.

Suggested reinspection date: _____

Remarks: _____

Mr. E. G. Merkle
General Production Dept.
Minneapolis

September 14, 1966

bpw

RYEGATE WATER POWER

Refer to yours of May 25th.

Water wheels are designed for 13 ft. head, 86 RPM, 438 BHP and are 68" Samson type.

#1A	40"	Condition	fair			
#1	68"	"	"			
#2	68"	"	"			
#3	68"	"	"	New	Runner	1952
#4	68"	"	"	"	"	1959
#5	68"	"	"	"	"	1963

Richard S. Seaworth

-- OUR 104th ANNIVERSARY YEAR --

THE JAMES LEFFEL & Co.

MANUFACTURERS OF

HYDRAULIC TURBINES

SCOTCH BOILERS - STOKERS

CABLE ADDRESS: "LEFFEL SPRINGFIELD, OHIO"

SPRINGFIELD, OHIO, U.S.A. 45501

ESTABLISHED 1862

March 17, 1966 Via Air Special (2)

Ryegate Paper Company Division
Mountain Paper Products Co., Inc.
East Ryegate, Vermont

Att'n: Mr. T. F. LaHaise, Jr.
General Manager

Subject: Hydro-Electric Development and
Power Plant Rejuvenation and Improvement
Leffel W66-26

Gentlemen:

The purpose of this letter is to span the time since our initial phone conversation of 1-19-66 and the hydraulic turbine records that were referred to then and in subsequent correspondence and exchange of further information. With this background of your present layout plus the record of the six Leffel Samson turbines installed there in 1909 and therefore having available six penstocks (flumes) in which these present wheels are installed, and a layout which in general is like the drawing entitled "Revised plan and sections of Grinder Room - Ryegate Paper Company, East Ryegate, Vermont" No. 8487, we have proceeded with our study and are prepared to make the following recommendations for your consideration.

It is our intention and purpose to make all of this information in the form of a first draft proposal for consideration and to get a more complete study underway in regard to this water power improvement. This is coupled with the belief that the only way to proceed in a matter of this kind is to make specific recommendations and work from that point on.

It is our considered opinion, both from the present hydraulic study and from experience in revamping many plants of this kind, that there is presented in this case the possibility for decided

improvement in power and efficiency and gain in output with the utilization, under several of the plans at least, of a major part of your present construction including the civil works that comprise the flumes in which the turbines are set and the discharge pits into which they empty.

Under Propositions "A" and "B" (fixed blade propeller turbines) and Propositions "C" and "D" (adjustable blade propeller turbines) these units are planned to be placed in the present flumes with a minimum of change and alteration, the extent of which was indicated in certain drawings that will be referred to below. Under Proposition "E" there is suggested for consideration the so-called "flow through" type of horizontal turbine where it is visioned that there would be utilization to the maximum degree possible of existing structures but involving more change, of course, than with Propositions "A", "B", "C" or "D".

PRESENT TURBINES:
For all practical purposes it can be summarized in a statement that in each of the six present flumes there is installed an 68" vertical Samson turbine and the power of each of these wheels is transmitted through beveled gears to pulp grinders. All of this gearing and the pulp grinding equipment would be eliminated and the new vertical turbine that would be set in each flume would have extended shaft and would direct connect to vertical type generator on present floor elevation at elevation 102.0.

The present Samson turbines, while of a design for the period in which they were installed and the type of installation you have and in consideration also of the age of these turbines, could not be considered to form a part of a modern hydroelectric layout for maximum power and efficiency, nor are they adapted to the requirements of this type of installation. The advantage under Propositions "A" through "D" inclusive is that for practical purposes it can be said that each new wheel would set in approximately the same location as the present turbine and would utilize the flumes substantially as they are now and this is also true of the discharge pit on the basis that these flumes and pits are in accordance with the dimensions on the drawings which have been referred to. It might be added that the knowledge that we have in connection with our own drawings and layout for these Samson wheels and our constant service of the Ryegate requirements through many years is a further advantage in working out this problem in the best possible way.

AVAILABLE HEAD:
It is our understanding that the available net effective head - normal range for these installations - will be from 14 ft. to about 14'6" and our curve sheets of performance and other data are worked up on that basis. In this connection we might also add that there are five of these flumes which are 14 ft. wide and one that is 15 ft. wide.

In the 14 ft. flumes - Propositions "A" (fixed blade) and "C" (adjustable blade) are the applicable units and then for the 15 ft. flume the Propositions "B" (fixed blade) and "D" (adjustable blade) could be installed and again all performance by way of curve sheets and other data on these various combinations will follow.

TYPE OF INSTALLATION:
In addition to all of the other data that will be submitted, including drawings, we are enclosing copy of Bulletin A-45 and a typical low head open flume installation like proposed is shown on the right hand side with all principal components clearly labeled and this design shows the turbine equipped with conical steel plate draft tube, a highly efficient and easily installed design, and we think for your conditions ideally suited; nevertheless, also we are enclosing sheet 1089E-65 and another typical open flume setting but with draft tube constructed of the elbow concrete type which could be used here but we think would involve much more construction work and expense is illustrated #12, and if for any reason it should be desired to use this elbow type concrete draft tube it could be about like #12.

GOVERNOR EQUIPMENT:
It is presumed that you desire each unit to be equipped with its own direct connected Woodward Type "HR" oil pressure governor for regulating the turbine, according to the closest speed regulation possibilities. The Type "HR" governor is illustrated in Woodward Bulletin 14022-B enclosed. These governors are fairly expensive items and we mention this because, depending on your method of operation or whether, for example, these units would be tied in to a large electrical system or otherwise synchronized with a block of power that it might not be necessary to have a complete governor on each unit. To specifically pinpoint from there, each unit could be equipped with a limitorque or motor operated gate mechanism connected to the top end of the gate shaft. While such a unit would not give close speed regulation this may not be necessary as has already been stated and the cost of the limitorque design would be about one-half the cost of a governor. In short, probably by using a limitorque instead of a governor a saving of somewhere around $5,000 for each unit could be made. The details of this we can discuss further at the proper time.

GENERAL TURBINE DESIGN:
For Propositions "A" and "B" the turbine runners would be of cast steel construction and propeller type and the inset picture at the bottom of Bulletin A-45 page 1 is a good view of such a type of runner - also photograph L-1146 shows another view of such a runner. When it comes to Propositions "C" and "D" the adjustable propeller type photographs L-958, L-961, L-962 and L-963 will apply. These are the movable blade runners and are, as stated, applicable in Propositions "C" and "D". Moreover, when it comes to Proposition "E", which is a flow through type of turbine, the same illustrations of the adjustable runners Propositions "C" and "D" will apply.

We might say also that sheet 1965-2 enclosed illustrating a galaxy of various designs of turbines shows a number of these propeller turbines in the upper right hand corner.

For a complete assembled open flume type of turbine but partaking of all of the advantages that are incorporated in the largest kinds of turbines, viz; the fixed stay ring and guide vanes see photograph L-1043 which will apply and this pertains to all four propositions "A" through "D" inclusive but not to Proposition "E".

FIXED BLADE PROPELLER TURBINES:

PROPOSITION "A":

Curve Sheet 2722 applies with performance for each of these units to operate at synchronous 60 cycle speed of 225 RPM. The drawing applicable, which would be for the five fixed blade turbines for 14 ft. width flumes is #51303 with the turbine set in open flume 14 ft. wide equipped with turbine and gate shafts to connect to generator and governor on the floor at elevation 102.0.

PROPOSITION "B":

This proposition contemplates the type of fixed blade turbine for the one 15 ft. wide flume and the performance is shown on Curve Sheet 2723 and the applicable drawing is #51304.

ADJUSTABLE BLADE PROPELLER TURBINES:

PROPOSITION "C":

Curve Sheet 2724 applies with performance for each of these units to operate at 200 RPM and five of these units could be utilized each in the 14 ft. wide flumes. The drawing applicable is #51305 and it is the same general setting as on the foregoing propositions for fixed blade turbines except with the adjustable blade it is necessary to have a steel well from the top of the turbine extending up to connect to the generator on the generator floor and have this in a dry well for access to the bearing and for the adjustable blade mechanism that comes up through the shaft but otherwise the setting is just the same.

PROPOSITION "D":

For the 15 ft. wide flume - adjustable blade propeller turbine - to operate at 200 RPM - Curve Sheet 2725 applies and the applicable drawing is #51306.

FURTHER COMMENT ON FLUME SIZE AND CAPACITY OF UNITS:

We believe that we have made clear that in the 14 ft. wide flumes Propositions "A" and "C" would apply with the capacities and speeds and all other details as outlined therein and in each case there would be five of these units.

There is one flume 15 ft. wide and this permits a larger size turbine and under this Propositions "B" and "D" apply.

If for any reason you wanted to make all of the units of the same size this could readily be done but that would mean installing the same size unit in the 15 ft. flume as in the 14 ft. flumes

and would cut down a bit on capacity but would make them all the same. Moreover, there would be nothing to stop putting in a combination of fixed and adjustable in whatever groups might be desired and such a selection can readily be made from the data we are submitting.

It should be explained that the reason for offering both fixed and adjustable blade types of turbines is that for the same flume width - and still without getting into excessive water velocities, although it does speed the water up, the adjustable blade type of turbine will make more water through it for its physical size and in the same width of flume than in the fixed blade and, therefore, we thought you might want to consider both designs under these circumstances. It is, of course, true that the cost of the adjustable blade turbines and generators will be somewhat higher.

We are not in this present letter including any figures on cost as our Engineering Department is now working on that and that data will come out shortly but this above information and what is to follow is being rushed to you by Air Mail Special Delivery because our factory engineer, Mr. Byron Winkler, together with Mr. W. H. Whitty of Whitty Engineering Company, are planning on seeing you at your office the first of next week, that is the week beginning March 21st and present anticipation is that it will be on that day. By getting this material to you we thought you would have an opportunity of looking it over before they come and this might be helpful to you. We also expect by that time to have in your hands a separate letter with approximate pricing so that the story will be complete in that regard.

PROPOSITION "E":
Flow through type of turbine. We have already given you above pictures of the adjustable blade type of turbine and that type would apply in Proposition "D" but would not be what we call a "flow through" type of setting, which will be like Drawing 51307 and the performance of each unit would be at 138 RPM (please note the large capacity of these units) as per Curve Sheet 2726. This type of turbine under Proposition "E" of the "flow through" design would be applicable to all six of the flumes and the adaptation of the design to your present conditions is illustrated as clearly as we can by Drawing 51307 and our engineers will discuss this in more detail. This type of turbine can connect to a standard water wheel driven horizontal generator at 138 RPM and we furnish integral coupling to connect to the generator shaft and including the coupling bolts.

GENERATORS:
The generators in all cases are not included herein but they are all of standard type as manufactured by the principal builders and it is our understanding that you are in position to get the estimating figures on these generators to match up with the turbines very readily. Our engineers will be glad to discuss this also.

This "flow through" type of turbine is a concept that is receiving some discussion in engineering circles but with a very limited number of installations in this country. While it has much merit, as our engineers will discuss, it is somewhat depending on your desires and what you are willing to do under the present structure as to its use.

FURTHER COMMENT ON DESIGN TO BE USED:
As covered above the principal sizes and types are considered but we are ready to discuss any changes and invite a thorough study and conclusion at the time our engineers visit you and then we will supplement this data if necessary to any extent desired.

PRICES:
The approximate estimating prices, as stated above, are being figured in our Engineering Department now and will be in a separate letter but to correspond with designations as given in this letter alphabetically and otherwise.

We appreciate this opportunity of studying the matter with you and, as stated, the 104 years experience we have has been to a great extent discussed and directed to such installations and we are an independent manufacturer, not affiliated with any other organizations, and the only one of its kind in the country today. We believe we are able to offer the most favorable service from every viewpoint.

Thanking you and with kind regards, we are

Very truly yours,

THE JAMES LEFFEL & COMPANY

J. Robert Groff
President and General Manager

JRG:dr
in duplicate

Enclosures - in duplicate
Bulletin A-45
Sheet 1089E-65, 1965-2,
Woodward Bulletin 14022-B
Curve Sheets 2722, 2723, 2724, 2725, 2726
Drawings 51303, 51304, 51305, 51306, 51307
Photographs L-1146, L-958, L-961, L-962, L-963, L-1043

Copy to:
Mr. W. H. Whitty
Whitty Engineering Company
1874 Centre Street
West Roxbury
Boston, Massachusetts 02132

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 17.01

Town Bath: County Grafton

Stream Conn. River

Basin-Primary Conn River: Secondary

Local Name

Coordinates—Lat. 44° 10' +15,200: Long. 72° 5' -1500

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 3215 Sq. Mi.

Overall length of dam 335 ft.: Date of Construction

Height: Stream bed to highest elev. 26' ✓ ft.: Max. Structure 14' ✓ ft.

Cost—Dam: Reservoir

DESCRIPTION W C Rib Dam-Logs Timber-Ledge Found.

Waste Gates

Type (Log Sluice 20' long 3.5' deep)

Number: Size ft. high x ft. wide

Elevation Invert: Total Area sq. ft.

Hoist

Waste Gates Conduit

Number: Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width: Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway: Left of Spillway

Spillway

Materials of Construction Timber

Length—Total ft.: Net 275.2' ft.

Height of permanent section—max. 12' ft.: Min. ft.

Flashboards—Type: Height 18" ✓ ft.

Elevation—Permanent Crest: Top of Flashboard

Flood Capacity 73,135 cfs.: 35 cfs/sq. mi.

Abutments

Materials: Ledge

Freeboard: Max. 14' ✓ ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Wyman Paper Co. E. Wyman, Vermont

REMARKS Condition Fair

Tabulation By U.S.G.S. & R.L.P. Date [illegible]

Form E1A
4845

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5285

TOWN: BATH	TOWN NO.: 1	STATE NO.: 17.01
RIVER / STREAM: Connecticut River		
DRAINAGE AREA:	POND AREA:	
DAM TYPE: Crib	FOUNDATION NATURE OF: Ledge	
MATERIALS OF CONSTRUCTION: Logs, Timber		
PURPOSE OF DAM: POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM: 26'	TOP OF DAM TO SPILLWAY CRESTS: 14'	
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM: 375.33'	LENGTH OF DAM: 485' Approx.	
FLASHBOARDS TYPE, HEIGHT ABOVE CREST: 16"		
OPERATING HEAD CREST TO N. T. W.: 13'	TOP OF FLASHBOARDS TO N. T. W.: 14'	
WHEELS, NUMBER KINDS & H. P.: 6-68" Leffel Samson 1-40" " " 2500 HP Total		
GENERATORS, NUMBER KINDS & K. W.: 1-25 KW		
H. P. 90 P. C. TIME 100 P. C. EFF.	H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS		

REMARKS

OWNER: Ryegate Paper Co.

CONDITION: Fair

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made July 22, 1936, according to notification to owner dated July 14, 1936, and bill for same is enclosed.

B-10

D. Waldo White
Chief Engineer

August 6, 1936
Copy to owner

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 1 — I-5285

RIVER [illegible] MILES FROM MOUTH 264.65 D.A.–SQ.MI. 224 [illegible]

TOWN Bath OWNER Ryegate Paper Company, E. Ryegate, Vt.

LOCAL NAME OF DAM [illegible]

BUILT ____ DESCRIPTION [illegible]

POND AREA–ACRES ____ DRAWDOWN–FT. ____ POND CAPACITY–ACRE FT. ____

HEIGHT–CREST TO BED OF STREAM–FT. 26 MAX. ____ MIN. ____

OVERALL LENGTH OF DAM–FT. 435 ± MAX. FLOOD HEIGHT ABOVE CREST–FT. ____

PERMANENT CREST ELEV. U.S.G.S. ____ LOCAL GAGE ____

TAILWATER ELEV. U.S.G.S. ____ LOCAL GAGE ____

SPILLWAY LENGTHS–FT. 375.33 FREEBOARD–FT. 12

FLASHBOARDS–TYPE, HEIGHT ABOVE CREST 1.3

WASTE GATES–NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

REMARKS [illegible]

3E

POWER DEVELOPMENT

UNITS NO.	RATED HP.	HEAD FEET	C.F.S. FULL GATE	KW.	MAKE
1	Total	12			60" Leffel Samson
1	2500	12			68" [illegible] Samson
1				25	
	2500	13	WRB [illegible]	1370	

USE Power

REMARKS WRB [illegible] 1200 KW

B-11

DATE 1936

File No. Washington
Field N. H. 1007.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

REPORT ON DEVELOPED WATER POWER

1. Name of stream on which power is located Connecticut River

2. Location of plant: ¼ Sec. ....., T. ....., R. .....

Town or City Bath (East Ryegate, Vt.), County Grafton, State N. H.

3. Location of point of diversion Bath, N. H. (East Ryegate, Vt.)

4. Name and address of owner or operator Ryegate Paper Co., East Ryegate, Vt.

5. Operating head, fore bay to tailrace 12 feet.

6. Water wheels:

No.	Kind	Make	Size	Rated capacity (horsepower)
6		Leffel	68"	
1		Crocker	36"	
			Total	2,400

7. How many and what wheels are operated during the low-water season?

Varies

8. What is the ordinary length of such low-water season? 3 months

9. Generators: No. 1 Total rated capacity ~~xxxx~~ 66 K.W. (by steam)

10. Use of power Paper mill

11. Average number of hours per day plant runs 24

12. Auxiliary power 66 K.W. steam plant

13. Storage reservoirs in addition to storage at dam

Number ..... Total capacity 4.1 billion cubic feet.

14. Date May 18, 1921 Prepared by C. H. P.

JULY, 1920

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
WATER RESOURCES BRANCH

File No. { Washington... / Field.....

Report on Plant of Ryegate Paper Co. on Connecticut River.

Dam No. 1

(Sign your report and note date of its preparation.)

Name of company Ryegate Paper Co.

N. H. Public Service Commission

Location of power plant On Connecticut River in East Ryegate, Vt.

Use of power To grind pulp and run heater room.

Head 12 feet.

No. of water wheels, size and make Six 68" Leffel, and one 36" Crocker.

How connected (shafts or belts) Shafts.

No. and size of generators (if hydroelec.) One 66 KW run by steam engine.

No. of hours a week wheels are operated 156 hours.

Does water go over dam when wheels are not operated? Yes

State approx. size of pond back of dam. 70,000,000 cubic feet.

Has company additional storage reservoirs? No

Is there sufficient water at all times? No.

How many days a year is there a shortage of water? 90 days.

Is auxiliary steam or elec. power used? Yes. Two 250 HP, and one 125 HP, and one 35 HP steam engines for paper machines and generator.

Is any increase of present development proposed; if so, what? No

Give information regarding output of plant, number and kind of employees, etc.

25 tons paper daily. Employees, 25 skilled and 50 unskilled men.

Date of inspection February 8, 1919 By M.R. Stackpole

N. H. 1007.

DAMS IN NEW HAMPSHIRE

Date Feb. 8, 1919.

OWNER Ryegate Paper Co.

ADDRESS East Ryegate, Vt.

Location (definite) Give name of stream and its position relative to physical landmarks, etc. On Connecticut River in town of Bath, N. H. and East Ryegate, Vt.

Type of construction (timber, concrete, etc.) Timber

Height of dam 12 feet

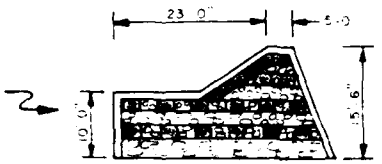
Length of dam 375 feet

Length of spillway section Log sluice 22' wide, 3' deep. Water spills over entire length of dam when water is high enough.

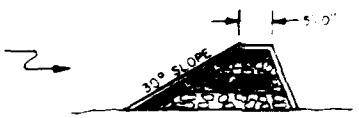
Would failure of dam cause serious damage to property below? No.

In what condition is dam at present? Good.

(Note; A-good, B-fair, C-poor.)

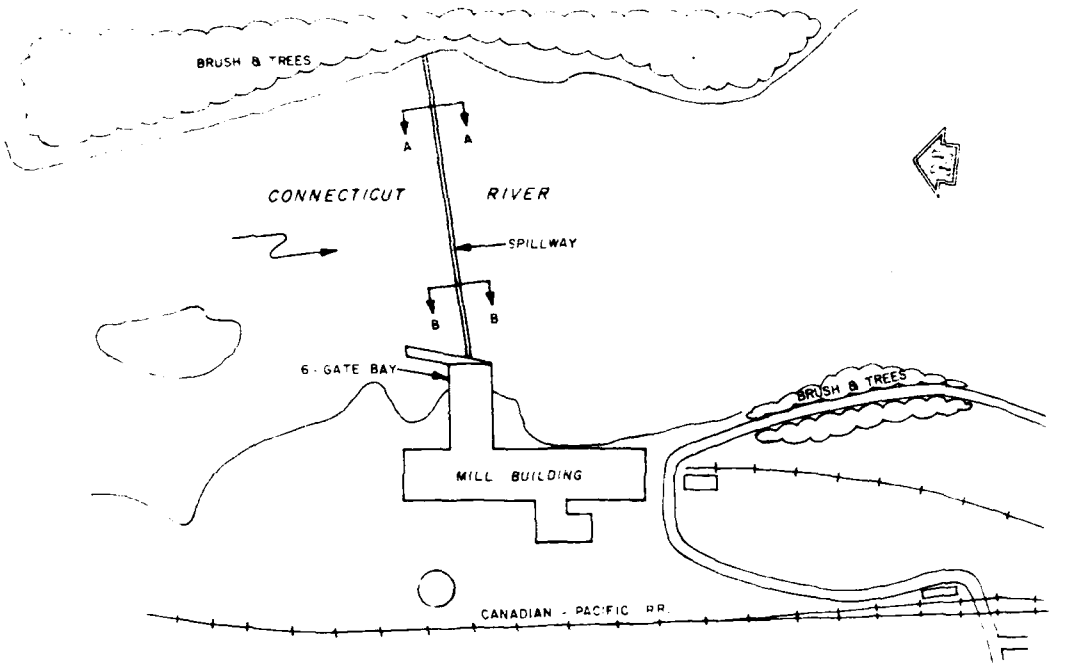


A-A

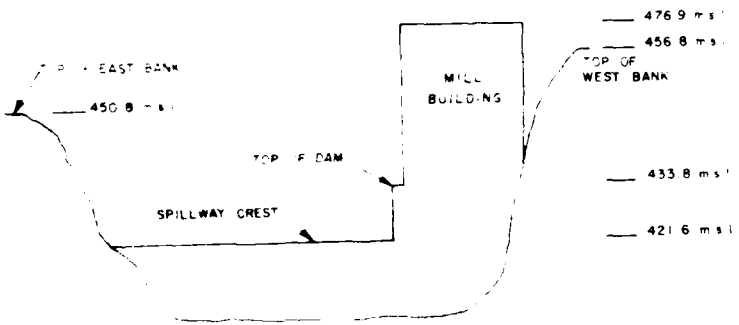


B-B

SPILLWAY SECTIONS



PLAN



ELEVATION

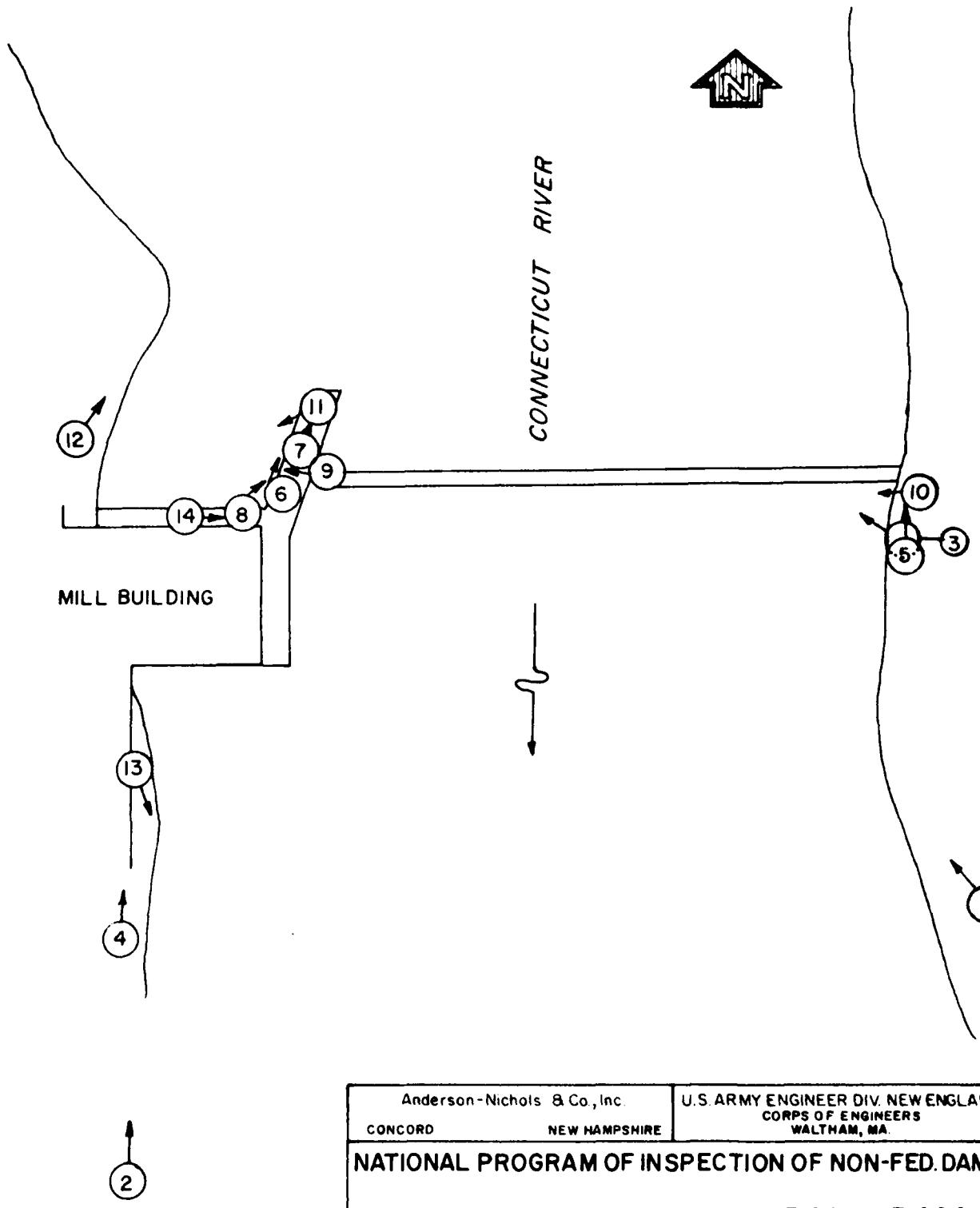
Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

RYEGATE PAPER COMPANY DAM

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

RYEGATE PAPER COMPANY DAM
PHOTO INDEX

CONNECTICUT RIVER NEW HAMPSHIRE

			SCALE: NOT TO SCALE
			DATE: JUNE 1979

Figure 2 - Looking west across the dam from the east abutment.

Figure 3 - Looking at the downstream face of the dam near the east bank. Note the sag in the crest.

Figure 4 - View of the mill building which comprises the west abutment of the dam.

Figure 5 - Looking upstream at the east abutment of the dam.

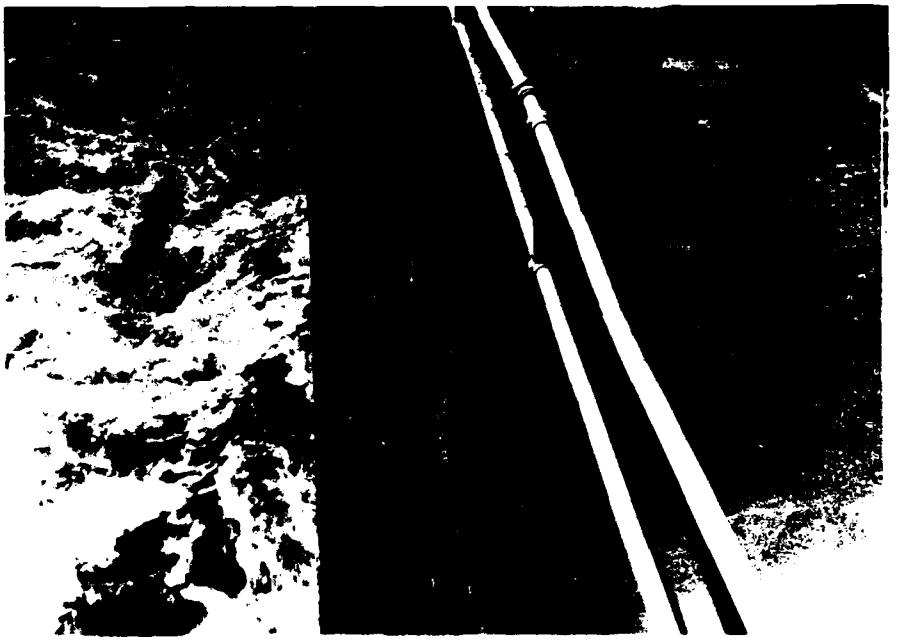


Figure 6 - View of the surface deterioration of the training wall.

Figure 7 - Looking at the transverse crack in the center of the training wall.

Figure 8 - View of high-level gate and low-level gate stem.

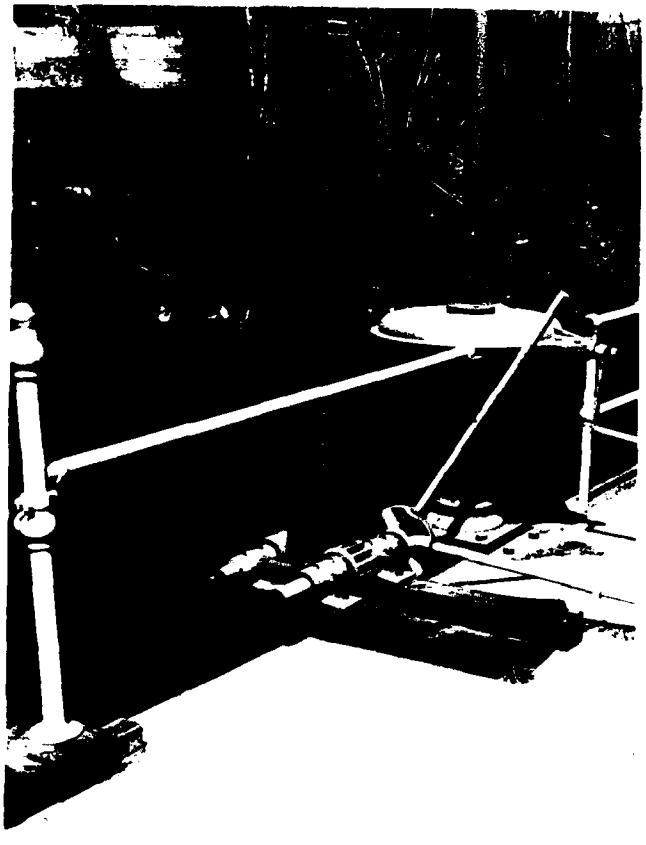


Figure 9 - Looking at the gate mechanisms which control the high-level and low-level gates.

Figure 10 - View of training walls and openings.

Figure 11 - Looking at the inlet gates to the mill which form the portion of the dam between the training wall and west abutment.

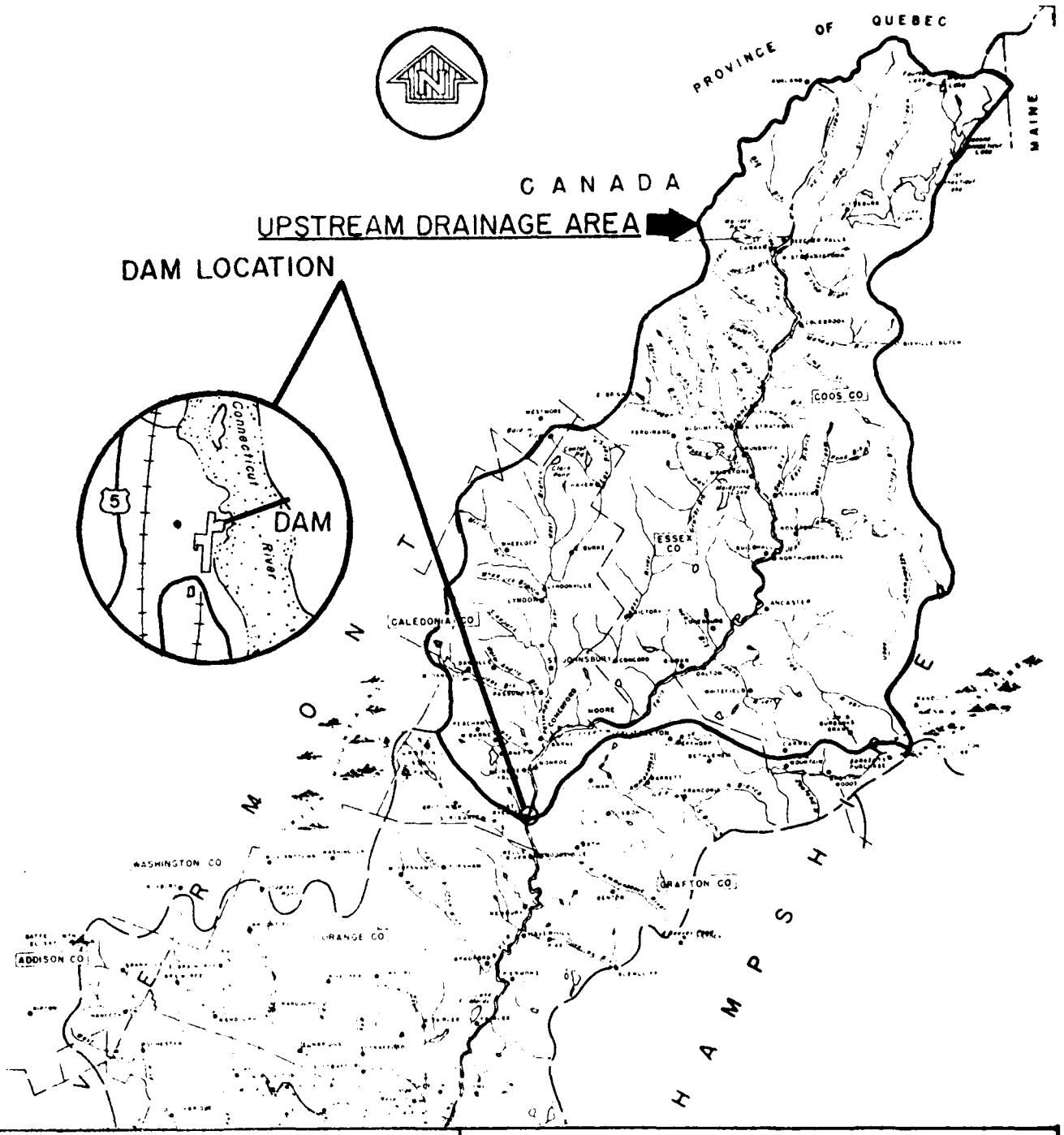
Figure 12 - Looking upstream into the reservoir from the west abutment of the dam.

Figure 13 - Looking at the downstream channel from the west abutment.

Figure 14 - View of the 1936 flood highwater mark.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

RYEGATE PAPER COMPANY DAM

BATH, NEW HAMPSHIRE

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC. CONCORD, NH

NOT TO SCALE

MAP BASED ON CONNECTICUT RIVER, GENERAL BASIN MAP. JUNE 1970

DA = 2215 s.m. (Water Resources Board)
SIZE CLASSIFICATION: INTERMEDIATE
HAZARD CLASSIFICATION: LOW
TEST FLOOD: $\frac{1}{2}$PMF

NEGLIGIBLE STORAGE UPSTREAM THAT WOULD ATTENUATE FLOOD FLOW

ESTIMATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1978.

FROM EXTRAPOLATION OF ROLLING CURVE OF MAXIMUM PROBABLE FLOOD, PEAK FLOW RATES FOR DA = 2215 SM.

MPF RATE ≃ 100 CSM

MPF = 110 CSM (2215 SM) = 243,650
∴ 1/2 MPF = 121,825 CFS

CHECK OF MPF: 1/4 PMF ≃ 100 YEAR FLOW
1/4 (243,650) = 60,910 CFS

FROM "COMPREHENSIVE WATER AND RELATED LAND RESOURCES INVESTIGATION - CONNECTICUT RIVER BASIN - JUNE 1970", TABLE C-10 NATURAL PEAK DISCHARGE - FREQUENCY FOR RYEGATE DAM

Q_{100} = 67,000 (9% DIFFERENCE W/ 1/4 PMF)

USE: 1/2 PMF = 121,800 CFS

SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

DETERMINE SPILLWAY RATING CURVE

TAILWATER RATING CURVE

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

$n = n_{composite}$

$S = S_{BOTTOM} = \frac{406.10 - 399.75}{4.5\,(5280)} = 0.0003\,ft/ft$

ELEV.	A	W.P.	R=A/WP	$R^{2/3}$	n_{comp}	Q	
406.10	—	—	—	—	—	0	
410.65	1410	500	2.82	200	0.030	3131	
420	6085	561	10.85		0.032	24,023	
437.7						58,000	1936 FLOOD

SPILLWAY RATING CURVE (W/NO TAILWATER INFLUENCE)

$$Q = C L H^{3/2}$$

C = 3.7 OVER SPILLWAY (King & Brater)
2.6 OVER OVERBANK

L_1	ELEV.	H	$H^{3/2}$	Q_1 (OVER SPILLWAY)
	421.6			0
"	422.6	1.0	1.0	1443
"	427.4	5.8	13.97	19,329
"	430.7	9.1	27.45	37,987
"	433.8	12.2	42.61	58,968
"	450.8	29.2	151.79	218,347

ARES -N. SCALE

L_2	ELEV	H	$H^{3/2}$	Q_2 (over OVERBANK)
	421.6			0
17	422.6	1	1	44
"	427.4	5.8	13.97	618
"	430.7	9.1	27.45	1214
"	433.8	12.2	42.61	1884
"	450.8	29.2	157.79	6974

L_3	ELEV	H	$H^{3/2}$	Q_3 (over OVERBANK)
	421.6	0		0
	422.6	0		0
	427.4	4.8	10.52	382
	430.7	8.1	23.05	840
	433.8	11.2	37.48	1364
	450.8	28.2	149.79	5450

L_4	ELEV	H	$H^{3/2}$	Q_4 (over overbank)
	421.6			0
	422.6			0
	427.4			0
19	430.7	3.3	5.99	296
"	433.8	6.4	16.19	800
"	450.8	23.4	113.19	5592

L_5	ELEV	H	$H^{3/2}$	Q_5 (over overbank)
	430.7			0
57	433.8	3.1	5.46	808
"	450.8	20.1	90.11	13,354

L_6	ELEV	H	$H^{3/2}$	Q_6 (over west overbank)
	438.6			0
43	450.8	12.2	42.61	4764

ELEV.	$Q_T = \sum_{i=1}^{6} Q_i$
421.6	0
422.6	1487
427.4	20,329
430.7	40,337
433.8	63,824
450.8	254,481

SPILLWAY DISCHARGE AS AFFECTED BY TAILWATER

- FROM V.T. CHOW "OPEN CHANNEL HYDRAULICS" & FIG-14-17 - SUBMERGED CREST COEFFICIENT - OVERFLOW CRESTS

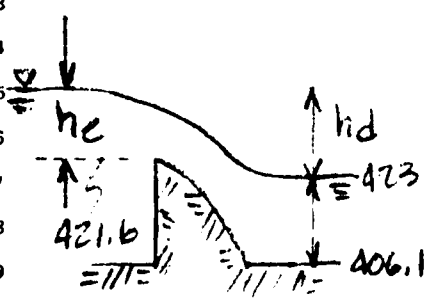
- DISCHARGE AT WHICH "C" VALUE IN WEIR FORMULA BEGINS TO BE REDUCED

Q = 30,000 CFS ✓

$h_d = 429 - 423 = 6$

$d = 423 - 406.1 = 16.9$

$H_e = 429 - 421.6 = 7.4$



$h_d / H_e = 6/7.4 = 0.81$

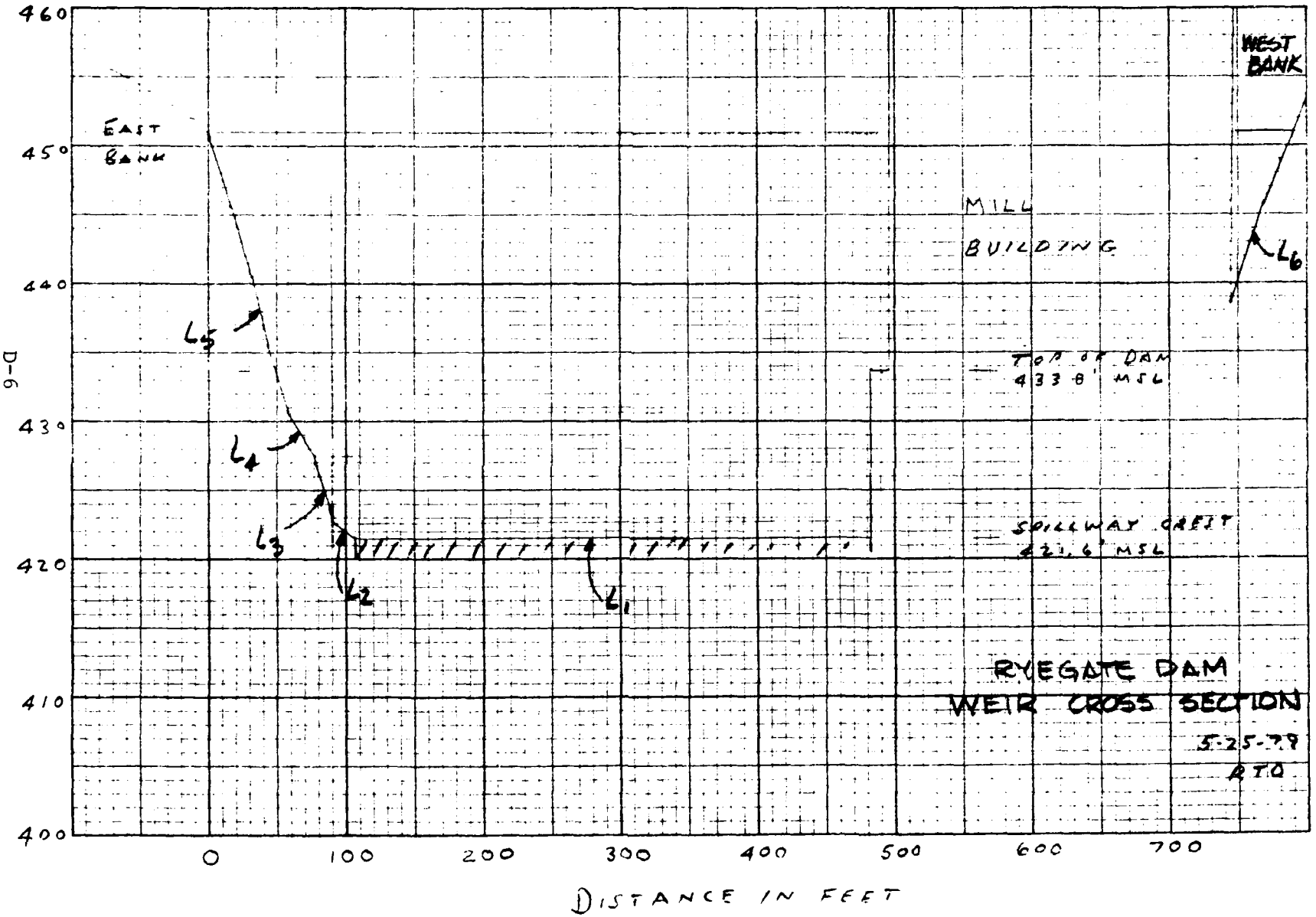
$(h_d + d)/H_e = (6+16.9)/7.4 = 3.1$

% slightly > 0%

Q = 58,000 (1936 FLOOD)

HEADWATER = 438.3

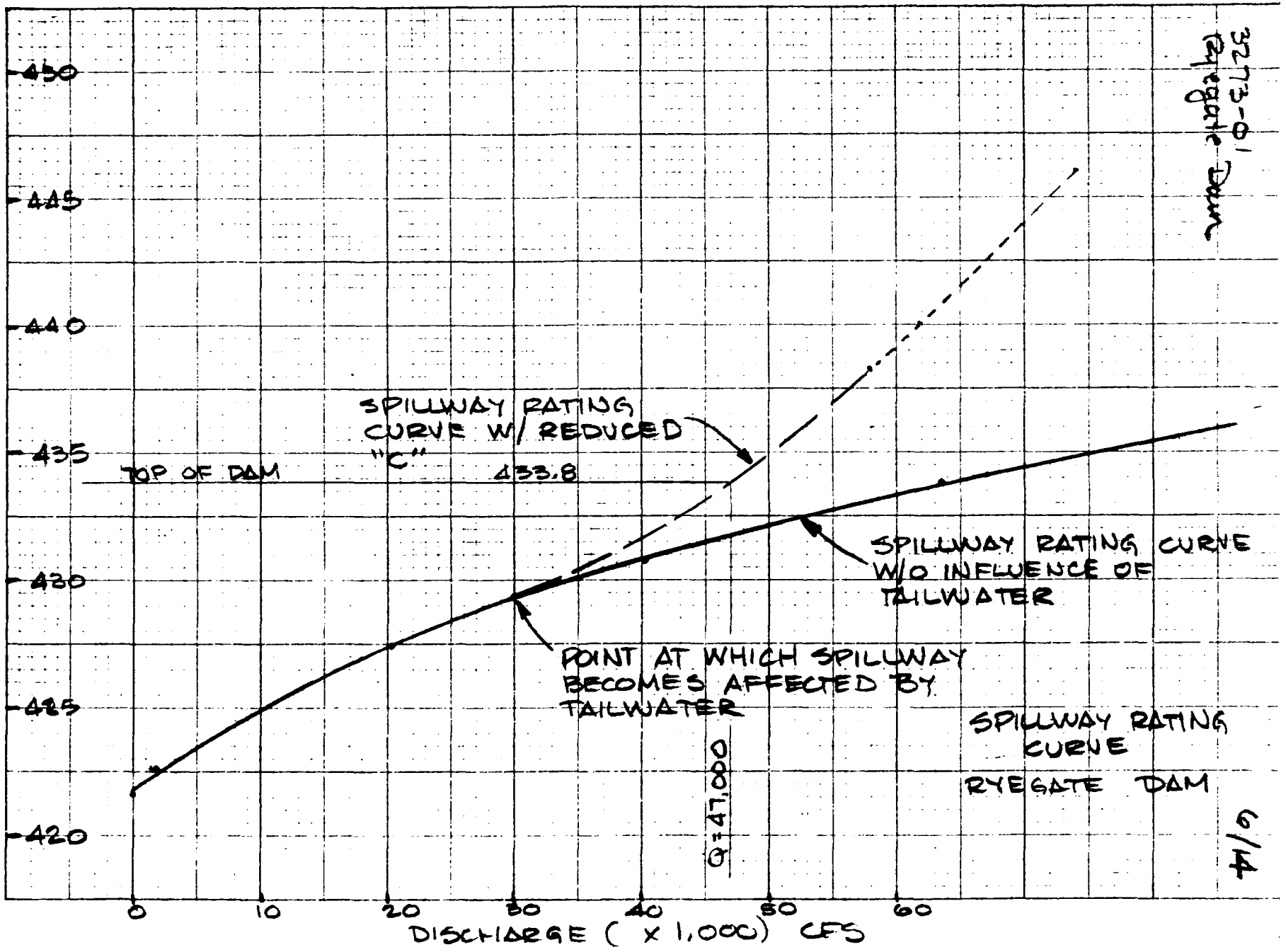
TAILWATER = 437.7

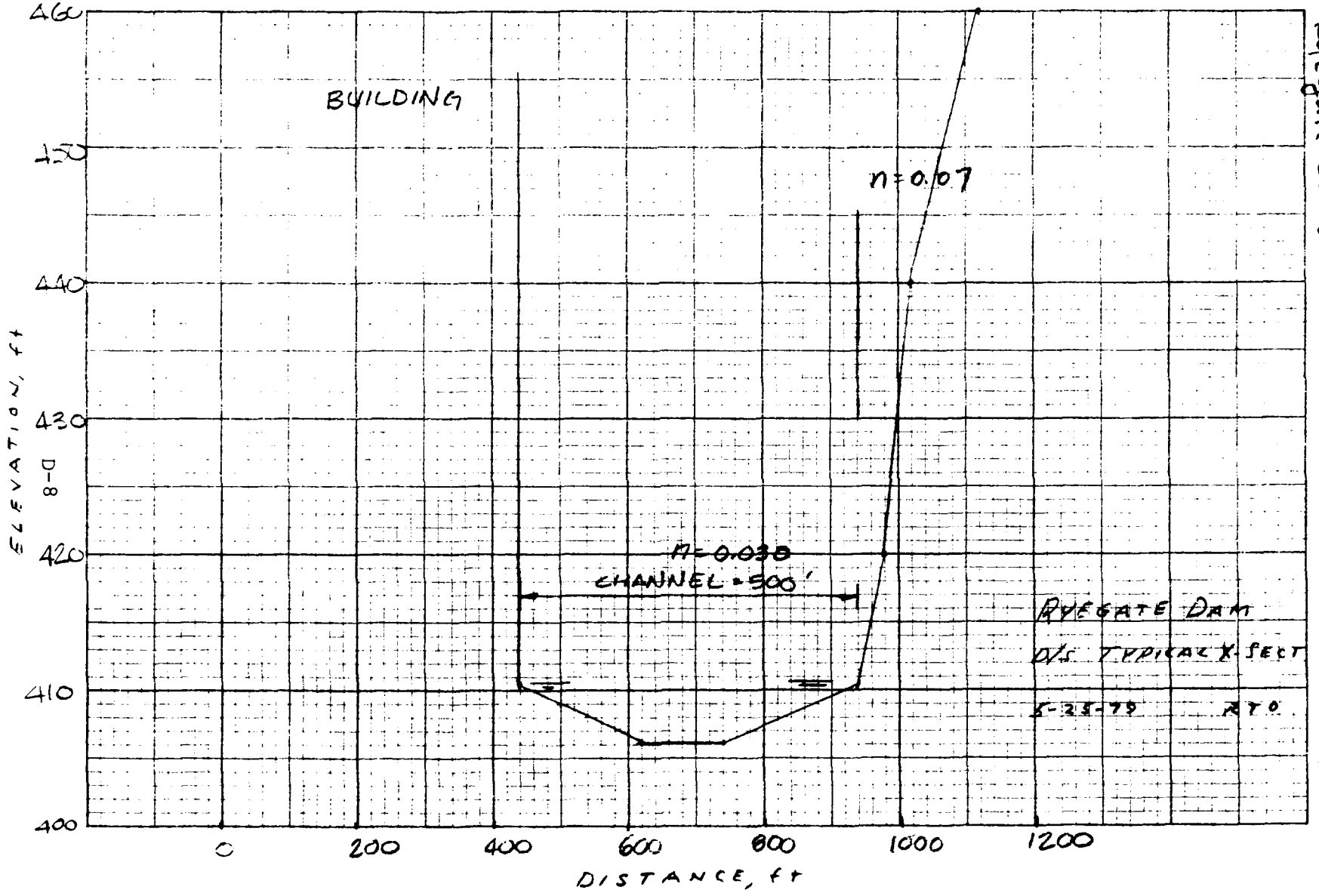


D-6

3273-C1
Ryegate Dam

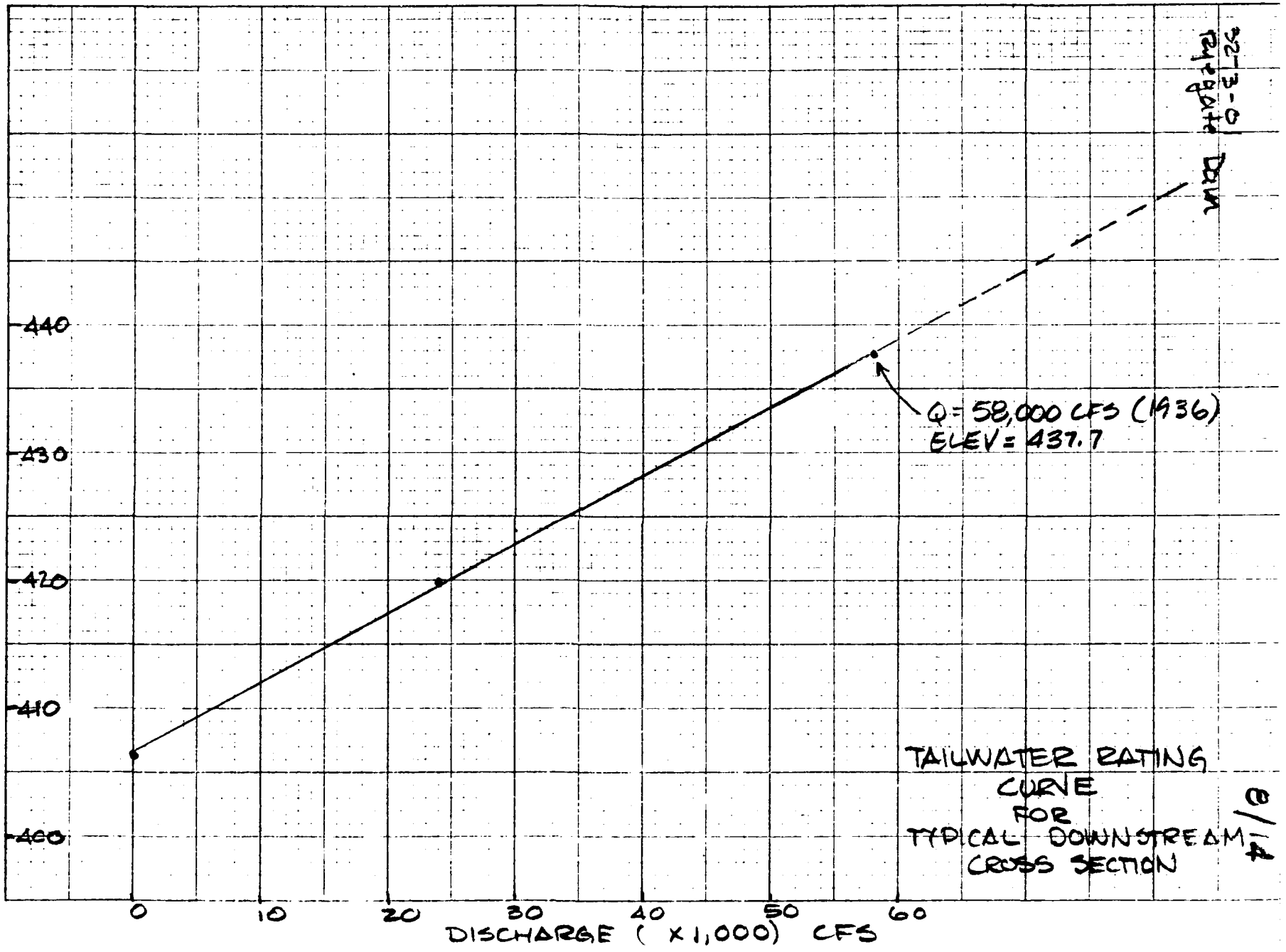
5/14


3273-01
Ryegate Dam
450
445
440
435
430
425
420
SPILLWAY RATING CURVE W/ REDUCED "C"
TOP OF DAM
433.8
SPILLWAY RATING CURVE W/O INFLUENCE OF TAILWATER
POINT AT WHICH SPILLWAY BECOMES AFFECTED BY TAILWATER
Q=47,000
SPILLWAY RATING CURVE
RYEGATE DAM
6/14
0
10
20
30
40
50
60
DISCHARGE (X 1,000) CFS



3273-01 Ryegate Dam

7/14



TAILWATER RATING CURVE FOR TYPICAL DOWNSTREAM CROSS SECTION

E/14

DISCHARGE AT TOP OF DAM, ELEV 433.8
= 47,000 CFS

AS % OF PMP = $\frac{47{,}000}{244{,}000} \times 100 = 19.3$ say 19%

GATE DISCHARGES

- LOW LEVEL - INDETERMINABLE SIZE FROM FIELD INSPECTION
- HIGH LEVEL - 4'x5'

$Q = C A \sqrt{2gh}$

$C = 0.7$

$A = 4 \times 5 = 20$ ft.

@ MAX. POOL - FLOW OVER DAM = 47,000 CFS
HEADWATER = 433.8
TAILWATER - 432.0

$h_{effective} = 433.8 - 432.0 = 1.8'$

$Q = 0.7(20)\sqrt{2(32.2)(1.8)}$

$Q = 151$ CFS (NEGLIGIBLE COMPARED TO TOTAL DISCHARGE)

BREACH ANALYSIS

TO DETERMINE DOWNSTREAM HAZARD CLASSIFICATION, FAILURE OF THE DAM WILL BE CONSIDERED AT TOP OF DAM POOL ELEV. (MAX. POOL @ LOWEST NON-OVERFLOW PT.)
= 433.8 MSL

$$Q_{P_1} = 8/27\, W_b \sqrt{g}\, y_o^{3/2}$$

W_b = BREACH WIDTH = $445 \times 0.40 = 178$
$g = 32.2\ ft/sec^2$
$y_o = 433.8 - 409.1 = 24.7'$

$$Q_{P_1} = 8/27(178)(\sqrt{32.2})(24.7)^{3/2}$$

$$Q_{P_1} = 36{,}740\ CFS$$

Q_{P_2} = FLOW OVER DAM OTHER THAN THRU BREACHED AREA

$$Q_{P_2} = C L H^{3/2}$$

$C = 3.7$ SPILLWAY, 2.6 OVERBANK
$L = 375 - 178 = 197$ (spillway); 57' (overbank)
$H = 433.8 - 421.6 = 12.2'$

$$Q_{P_2} = (3.7(197) + 2.6(57))(12.2)^{3/2}$$

$$Q_{P_2} = 37{,}380\ CFS$$

$$Q_{TB} = Q_{P_1} + Q_{P_2}$$ TB = TOTAL BREACH

$Q_{TB} = 36,740 + 37,380$

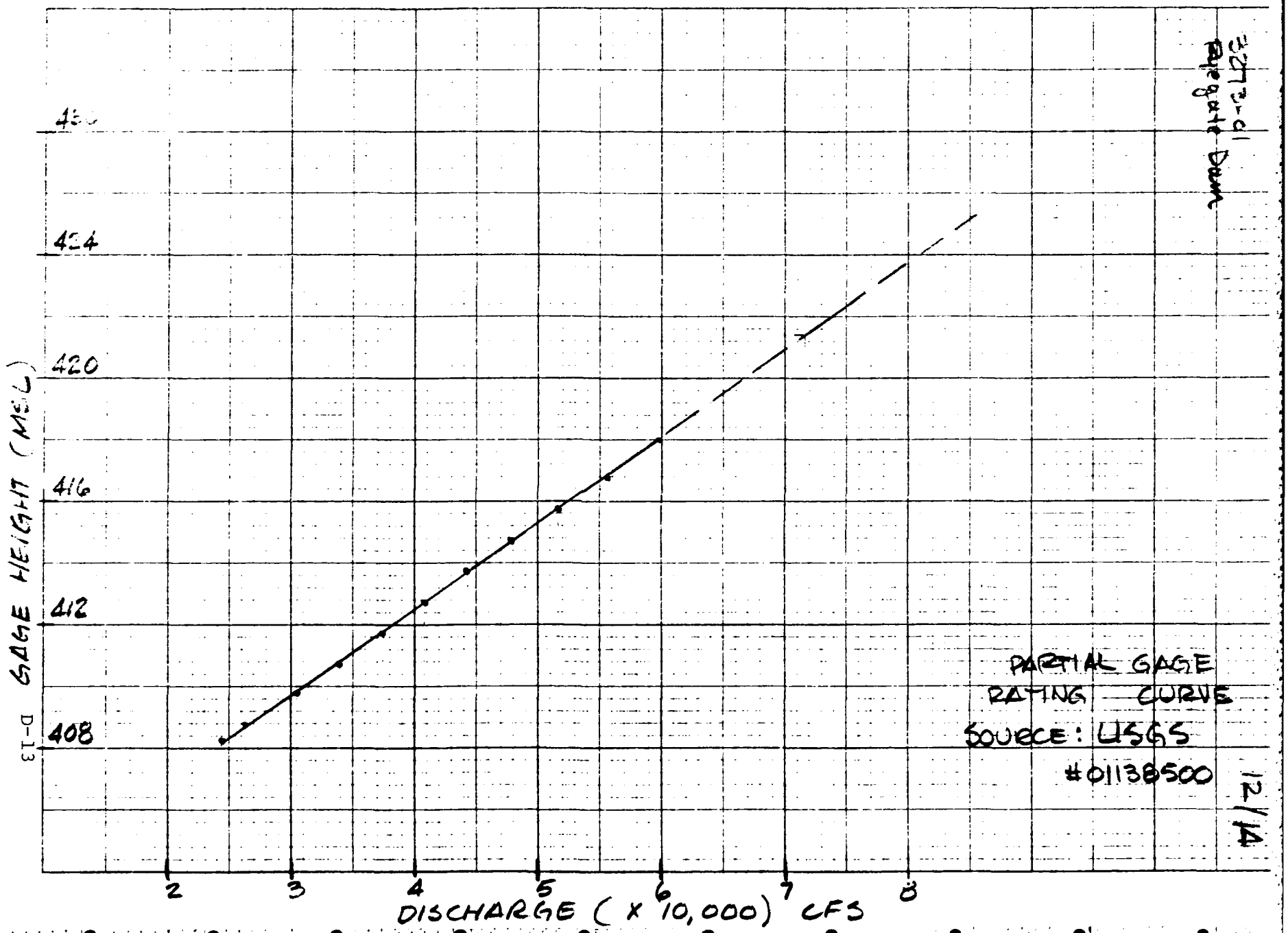
$Q_{TB} = 74,120$ CFS *

POTENTIAL HAZARD AREA CONSISTS OF A GROUP OF HOUSES, APPROXIMATELY 4.5 MI. DOWNSTREAM, ON THE BANKS OF THE CONNECTICUT R IN WOODSVILLE. THE HOUSES ARE JUST ACROSS FROM USGS GAGE #01138000.
DETERMINE FLOOD HEIGHT AT THIS LOCATION FROM THE GAGE RATING TABLE

NORMAL FLOW ON 5/17/79 - W.S. @ GAGE ≈ 403
∴ 403 - 399.75 ("0" GAGE) = 3'
FROM RATING TABLE Q = 3080 CFS

ASSUMING A BREACH AT 433.8 TOP-OF-DAM - FLOW OVER SPILLWAY = 47,000 CFS (See 6/13)
FROM RATING TABLE - DEPTH = 14.8' OR ELEV. 415'
(THIS ALSO ASSUMES LITTLE EFFECT DUE TO RIVER STORAGE OR INFLUENCE OF MINIMUM LATERAL INFLOW)

* NOTE: THIS VALUE IS THEORETICAL. AT 74,120 CFS HEAD- AND TAILWATER ELEVATIONS ARE THE SAME AND CREATE EQUAL HYDROSTATIC PRESSURE ON EITHER SIDE OF STRUCTURE RESULTING IN LITTLE PROBABILITY OF FAILURE.


428
424
420
416
412
408
GAGE HEIGHT (MSL)
2
3
4
5
6
7
8
DISCHARGE (X 10,000) CFS
PARTIAL GAGE
RATING CURVE
SOURCE: USGS
#01138500
12/14
D-13

ASSUMING A BREACH AT NORMAL FLOW CONDITIONS - FAILURE AT SPILLWAY CREST = 421.6 MSL - MAX TAILWATER COULD ONLY BE 421.6

FROM TAILWATER RATING CURVE
Q ≈ 27,000 CFS

AT HAZARD AREA - FROM GAGE RATING TABLE @ Q = 27,000 CFS

ELEV = 408.9 say 409'

WAVE HT. = DIFFERENCE IN HEADWATER AND TAILWATER CONDITIONS WITH FLOW OCCURING AT TOP OF DAM.

HEADWATER @ 47,000 CFS = 433.8
TAILWATER @ 47,000 CFS = 432.-

INCREASED STAGE = 1.8'

CONCLUSIONS ON HAZARD

RYEGATE DAM IS A LOW HAZARD DAM

POTENTIAL HAZARD AREA IS A DEVELOPED AREA OF 14 INHABITED STRUCTURES (HOUSES) (ELEV. ≈ 415) APPROX. 4.5 MI DOWNSTREAM OF THE DAM IN WOODSVILLE.

AS WELL AS AN ADDITIONAL 7 INHABITED STRUCTURES (ELEV ≥ 420) AND THE NATIONAL GUARD ARMORY ANOTHER 0.5 MILES DOWNSTREAM OF THE 7 HOMES.

ANTECEDENT FLOW OVER SPILLWAY JUST BEFORE A BREACH AT TOP OF DAM WOULD ALREADY CREATE A FLOODING AND DAMAGE SITUATION BEFORE DAM FAILURE (HOMES AT ELEV ≥ 415). THE SMALL INCREASE IN STAGE DUE TO FAILURE THOUGH PROBABLY DISSIPATED BY THE TIME IT REACHES DAMAGE AREA, WILL NOT INCREASE DAMAGES SIGNIFICANTLY (NEXT MAJOR DAMAGE OCCURS AT ELEV. 420)

A BREACH AT SPILLWAY CREST COULD NOT BE ATTRIBUTABLE TO ENOUGH WATER AT THE DAMAGE AREA TO RAISE WATER SURFACE ELEV.'S TO THE FIRST DAMAGE ELEV. (405 < 415)

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	ID NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
NH	14	NED	NH	009	02	VT	005	01	RYEGATE PAPER COMPANY DAM	4412.5	7203.5	04JUN79

POPULAR NAME	NAME OF IMPOUNDMENT
RYEGATE DAM	CONNECTICUT RIVER

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	CONNECTICUT RIVER	RYEGATE VERMONT	1	830

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
ERPGOT	1909	D	28	28	7985	4360	NED	N	N	N	N	

REMARKS
20-1970 21-TIMBER CRIB 22-PRIOR TO 23-INDUSTRIAL

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
3	485	U	375	47000												

OWNER	ENGINEERING BY	CONSTRUCTION BY
CLAREMONT PAPER MILL	GEORGE F HARDY	

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BD	NH WATER RES BD	NH WATER RES BD	NH WATER RES BD

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
ANDERSON-NICHOLS + COMPANY INC	07MAY79	PUBLIC LAW 92-367

REMARKS

END

FILMED

8-85

DTIC